LESSON 1 INTRODUCTION

As you become more familiar with CHPS in your role as the Configuration Focal Point, you can focus on optimizing the system to provide additional benefits to internal and external partners.

This lesson describes the CHPS Configuration Focal Point's role in advanced configuration and reviews basic XML formatting.

By the end of this lesson, you should be able to:

- Describe the Configuration Focal Point's role in advanced configuration of CHPS.
- Review CHPS XML basics.
- List several XML resources.

1.2 ADVANCED CONFIGURATION

As the Configuration Focal Point, your responsibilities include configuring the displays and basic functions of CHPS.

The goal of this course is to help you identify additional opportunities to make CHPS work better for your RFC.

Part of your role as CHPS Configuration Focal Point is identifying opportunities to add functionality to CHPS to improve products and services, or improve system performance.

Examples of improvements include:

- decreasing the use of storage space by creating temporary time series
- establishing new data sources
- setting up a model from a university or another agency

This course provides you with ideas on how to handle the topics listed above, and gives you job sheets to help you complete the tasks.

Keep all opportunities for improvement at your office in mind as you go through this course, even if it is not specifically mentioned.

1.3 CONFIGURATION PROCESS

Take a few minutes to review the configuration process. If you need more in-depth information, please see Lesson 2 of CHPS Basic Configuration.

1. Download the most recent configuration from the Central Database.
2. Export the configuration file to the OC local datastore on your AWIPS workstation.
3. Edit the configuration file using an XML editor.
4. Import your configuration file into the Configuration Manager.
5. Validate the configuration.
6. Upload the configuration to the Central Database.

Cautions! Test new configurations thoroughly on the Stand Alone after editing the files! Stop MC-MC synch tasks when testing new configuration files! A bad or unwanted change could propagate through your entire system!

1.4 XML REVIEW

CHPS configuration utilizes XML (eXtensible Markup Language) as a framework for data.

Recall, XML does not perform an action; it simply provides structure and transportation for the information.

eXtensible - XML is not constrained to a set of predefined tags. You can define your own tags for CHPS XML.

Hints - Make sure the code within CHPS must conform to the XML Schema Definition (XSD), or the system cannot ingest the information. Do not create tags unless they are relevant and needed.

Editing Software - A benefit to using XML is you can edit it using a simple *text editor;* however, the NWSTC recommends using XML editing software.

Using *editing software* automatically adds closing tags, validates the code against the schema, and color-codes the syntax for easier editing.

Optimizing Code - Improving system performance may involve optimizing your configuration code. Optimization tends to reduce the number of lines of code, but it might contain more nested code. The nested code can be more difficult to read. Having editing software to check your work is very helpful!

Look at the list of **XML editors** on the next page to explore some of the editor options.

1.4.1 XML RESOURCES

Find additional information on XML on the following web pages.

- Extensible Markup Language (XML) - the World Wide Web Consortium (W3C)'s main XML page
- XML 1.0 (Fifth Edition) - the official XML specifications from the W3C
- O'Reilly xml.com - the authors of the O'Reilly series provide some basic information on XML and related formats
- New to XML - IBM provides an overview and links to open source projects and other products

XML Editors

CHPS does not contain an XML editor, so use the following links to research the best choice for your office.

- oXygen XML Editor - supports all of the XML schema languages
- Visual Studio - includes additional support for the XML languages (based on Microsoft Visual Studio Text Editor)
- XML Notepad - provides a simple intuitive user interface for browsing and editing XML documents from Microsoft
- Altova XMLSpy - an advanced XML editor for modeling, editing, transforming, and debugging XML-related technologies
- Stylus Studio Enterprise Edition 2010 - an "intuitive XML editing views and integrated XML troubleshooting utilities"

Some Online Tutorials include:

- w3's school's.com - provides free tutorials on XML, Schema, free editors, and reference books
- Free XML Class - from about.com
- XML Tutorial - from quackit
- XML Tutorial - from Academic Tutorials

LESSON 2 DATA HANDLING

Well-thought out changes to the configuration can improve system performance and decrease forecaster frustration. Use the techniques outlined in this lesson to accomplish both.

This lesson describes how to configure CHPS for new data and locations, and tips on how to improve data processing.

By the end of this lesson, you should be able to:

- Configure input for new data (dynamic) sources.
- Add a segment.
- Optimize ensemble runs for faster processing.
- Configure temporary time series to save space.

2.2 NEW DATA SOURCES

Having all of the available data from a source helps hydrologists make more informed forecast decisions. Adding a new data source is also an opportunity to evaluate how your office handles all of the information it receives.

Optimize the data flow in your CHPS system by making small changes to the way you handle the data. Changes can be applied to already established data and when adding new sources. Consider the following scenario:

Data is now available from a previously untelemetered site - the forecasters no longer need to call daily for data!

As a Configuration Focal Point, you must work with your team to add this new data source.

Your new data source needs to enter FEWS through the Import Module. Recall from Basic Configuration that the Import Module is one of the most important CHPS modules. Click here for a refresher on the five most common CHPS modules.

While you are setting up this or another new data source, also think about making the configuration more efficient.

Considerations

What is the data format? Make sure the file format is a CHPS-readable format. If not, the model cannot use the data and you must write an adapter. See Lesson 4.4 for more information on writing a General Adapter.

Is the data type already being imported? If the data type was not previously imported, add a new subdirectory to **/awips/chps_data/import** (or "toCHPS") on CHPS 3. If CHPS already uses the data type, you do not need to set up a new directory.

How many significant figures should be stored? Decide how precise the data must be. The native format is 32 significant digits. Balance the need for precision with the constraints of storing and processing the data.

How long is the data in the system? Determine the expiry time and use the job sheet below to make changes to your system.

Procedure for Adding a New Data Source

Configuration changes are necessary in order to ingest, process, and use the data in the correct workflows. Click the job sheet link at the bottom of the page for detailed instructions on adding a new data source.

Job Sheets: Adding a New Data Source | Changing Expiry Time

2.3 ADD SEGMENTS

After adding the new data source for ingest, make sure the workflows use the data and it appears in the Interactive Forecast Display (IFD). Adding a new segment to a forecast group, like adding a new data type, adds new information to the river forecast process. Adding a new segment also provides an opportunity to reevaluate how workflows are utilized in a forecast group.

Basic Steps

1. **Add** to Locations.xml, LocationSets.xml
2. **Create** Cold states, Workflow files
3. **Register** ModuleConfigFiles, WorkflowFiles
4. **Update** IFD, Topology
5. **Add** rating curve, Data
6. **Test and Upload** Spin-up runs, Validate on the SA

Preparation - The first step in defining a new segment is adding a map for the basin. Use GIS to define the basin boundaries and create a new background map.

Save the file and log the filename and directory. Instruction on using GIS is beyond the scope of this course. Check out some of the resources on the ESRI page and the NWS GIS Data Portal.

Locate all pertinent information for the site, including name, site identifier, and data types associated with the location.

Configuration - The next step is the configuration aspect of setting up a new segment. The job sheet below details all of the required configuration steps, but the graphic above is a general list of the necessary changes.

Use the job sheet below for details on how to configure a new segment.

Map the Workflow - The last step in the three-step process of adding a new segment is mapping the workflow. Open the Administration Interface and ensure the workflow for the new segment is mapped.

Unless this step is completed, CHPS will not recognize the new segment!

Job Sheet: Adding a New Segment

2.4 ENSEMBLES

Once you add the new data resource or segment, you can incorporate it into the ensemble. Even if the newly defined locations or data sources are already included in ensemble forecasts, looking at the ensemble configuration is worthwhile.

Ensembles take a long time to process and require a lot of computing power because of the number of calculations involved.

Consider the following to design more efficient ensemble runs:

More Efficient Workflow Mapping
You can run ensemble forecasts faster by splitting up the workflows over several Forecasting Shell Servers (FSSs). Edit configuration files AND schedule tasks in the Administration Interface to distribute the workflows. See the job sheet below for instructions on optimizing ensemble runs.

Some RFCs prefer to run all of the ensembles on one FSS in order to avoid scheduling conflicts. Work with other members of your staff to determine which approach is best suited for your office.

Use Statistics Wisely
What kinds of output statistics does your office need? A transformation utility within CHPS produces ensemble statistics.

The calculations done for ensembles require a significant amount of memory and can slow down processing times.

Ask the forecasters which statistics they use most often in the Time Series Display within the IFD. You may be able to identify unnecessary statistical calculations and improve system performance.

Use the following job sheet to make your ensembles run more efficiently.

Job Sheet: Optimizing Ensemble Runs

Reference: *Ensemble displays (Deltares wiki)*

2.5 TEMPORARY TIME SERIES

CHPS stores all data as a time series, but keeping too much data can affect system performance.

You can improve system performance and save space by marking data as temporary.

A **temporary time series:**

- only exists during the run in which it was created, and is referenced by the forecast model that produced it.
- is **not** synched to the rest of the system, and is deleted sooner than other time series.
- is assigned synch level 9, which tells the MC to skip it when synching data to various locations.

Example: Your forecast group contains a site where you create a synthetic flow (SQIN) and route it downstream for use in the next segment.

The information is helpful when forecasting downstream, but not needed again. Set the time series to "**temporary**" to delete it after the forecast run.

Setting a time series as "temporary" decreases synch time, causes less database fragmentation, and saves space in the datastore. For details on how to set a time series to temporary, see the job sheet below.

Job Sheet: Setting a Time Series to Temporary

LESSON 3 PRODUCTS

You completed the setup of new data sources and segments in CHPS. Now it is time to complete the configuration steps needed to create and send products to save lives and property.

This lesson provides information on configuring products and applications to enhance service to internal and external partners.

By the end of this lesson, you should be able to:

- Configure CHPS to use Pi-Service.
- List the steps in the configuration aspect of the Event Action feature.
- Describe inundation-mapping options in CHPS.
- Set up PCRaster.
- Create clickable maps and web applications.

3.2 PI-SERVICE

An excellent forecast, run on an efficient system, is only helpful if it is used. The Published Interface Service, or **Pi-Service**, extracts data from the databases in CHPS, making it available for use by other applications.

Data Exchange

Pi-Service is a data exchange format – one of many CHPS utilizes. One of the ways Pi-Service exchanges data is by taking the data from its native format and converting it into something CHPS can use.

Client Setup

In order to set up a Pi-Service client, you must have an Operator Client (OC) or a Stand Alone (SA), know the number of the port to which you are listening, and configure a FewsPiServiceConfig file for the OC or SA instance.

The CHPS System Manager module outlined the steps in setting up the directory structure for Pi-Service and editing the script. Click here for a refresher.

The Pi-Service files are located in the **PiServiceConfigFiles** directory and on CHPS 3 in the application directory.

One of the uses of Pi-Service is pushing model states to a WFO's Site Specific Headwater Predictor (SSHP).

Configure the service by defining:

- the type of data you are sending to the office,
- the locations for which the data is sent,
- and the directory to which the data is being pushed.

You **must** complete configuration changes **before** running the **fews_piservice.sh** script! The script requires guidelines on where to look for data and where to put it. Be sure the script output location is correct!

Once the configuration changes are complete, the SSHP data transfer is transparent to the WFO and RFC.

Use the following job sheet to help you configure Pi-Service.

Job Sheet: Configuring Pi-Service

References: *Setting up Pi-Service as a backend process (FogBugz wiki), and Pushing SSHP states (Deltares wiki).*

3.3 EVENT ACTIONS

Have you ever wanted to push a product to the web automatically? Issue a forecast if a threshold is crossed? Then setting up **Event Actions** would be helpful.

Event Actions are tasks configured to run after a variable reaches a certain value. Event Actions are configurable.

How Event Actions Work

The CHPS system generates log messages containing an event code. Those codes can be part of a configuration to trigger an event such as running a task or changing a task schedule.

Examples

Event Actions can be set up to perform the following:

- Trigger the export of HTML reports after a forecast is approved.
- Change the interval of a forecast from 12 hours to three.
- Start a forecast run once new external data becomes available.
- Send an email when a threshold is crossed (**Example:** System_Alerter task).

Setting Up an Event Action

Create an Event Action by setting up a configuration file and linking the action to the configuration in the Admin Interface.

1. Choose an event code to use as a trigger.
2. Create an action configuration file.
3. Upload the XML file from Step 2 to the Admin Interface, choosing a suitable action ID.
4. Create an Event-Action Mapping to link the event code and the action ID.
5. Schedule the appropriate task with the same tag as configured in the XML file.

Use the following job sheet to add an Event Action.

Job Sheet: Adding an Event Action

3.4 INUNDATION MAPS

Since CHPS is highly configurable, there are several options for output and products. Inundation mapping is an example of an additional product CHPS can produce. An inundation map depicts the area covered by water when a river stage is at a certain level.

Flood Mapping Module

CHPS comes with a flood-mapping module, which produces two-dimensional maps outlining inundated areas.

Before running the flood mapping module, you must obtain georeferenced cross sections (to correlate the model results with a location on the map), a digital elevation model (DEM), and a shapefile of the river in order to use the Flood Mapping module.

For more information on the flood-mapping module, click the reference link below.

Note: None of the RFCs use the Flood Mapping Module (as of 08/2012). Training will be updated as more information becomes available. If your RFC utilizes the Flood Mapping Module, please contact **Teresa Murphy** at teresa.murphy@noaa.gov for collaboration.

Using ArcGIS

ArcGIS is another option for creating inundation maps. Use the output from CHPS in ArcGIS to create these maps. Knowledge of GIS, in addition to CHPS configuration and system management skills would be required. Follow the FogBugz request for this function by clicking here.

Note: This training will be updated when more information about using FEWS output in ArcGIS becomes available. If your RFC utilizes ArcGIS for inundation mapping, please contact **Teresa Murphy** at teresa.murphy@noaa.gov for collaboration.

Collaborate! A universal solution for inundation mapping is not currently used in the RFCs, but there are a couple of options to explore. Communicate with your team and other RFCs to create procedures for inundation mapping to share with other offices.

Reference: *Flood Mapping module (Deltares wiki)*

3.5 PC RASTER

You can create additional products using third party software. PCRaster is an example of outside software RFCs can use with CHPS data to create gridded data, such as Flash Flood Guidance (FFG).

PCRaster, a type of environmental modeling software, utilizes GIS to create simulation models such as runoff models. No license is required for the software. Learn more about the software on the PCRaster web site.

PCRaster is also an efficient way of running model calculations for a large number of grid cells.

Transformation Module

The **pcrTranformation module** creates a direct link between FEWS and PCRaster.

The transformation module sends information to the PCRaster model. After the model runs, the transformation module reads and prepares the output to go back into CHPS. The data becomes available and is viewable in the IFD.

Configuring PCRaster

The schemas required for PCRaster, **pcRaster.xsd** and **pcrTransformationSets.xsd** are included by default, so configuration is limited to changing the module configuration file containing the pcraster code.

Considerations

- The units are the same as what is specified in the **Parameters.xml** file.
- Make sure the variables and constants are the same units.
- Define all variables you need after the model runs at the top of the file, rather than in the program. The results from the variables are stored in memory and will NOT be available after the model run unless defined in **Parameters.xml**!

Use the following job sheet to help you configure PCRaster to create gridded output from CHPS.

Job Sheet: Configuring PCRaster

Reference: *pcrTransformation module (Deltares wiki)*

3.6 WEB MAPS

River Forecast Centers relay information directly to the public through their web sites. The CHPS report module can help you send information from FEWS to a web server in HTML format.

Report Module

The focal point customizes the templates to format the data. The report module puts the data into the desired format, generates the reports from FEWS, and displays the reports in HTML format. The report templates can organize the information into text, charts, and tables. The maps can be exported and sent to a web server.

Setting up the Module

Generating the first report requires the Configuration Focal Points to follow several steps. After the initial set up is finished, the process is as simple as running a workflow. The process involved includes:

1. Set up a workflow to generate the report data
2. Register the workflow
3. Write the reports configuration file
4. Create an HTML template
5. Synch report output to the RFC web server for distribution to the web

For detailed instructions, see the job sheet below or click on the link to the Deltares wiki.

Exporting Maps

The report module takes data exported from FEWS and converts it to a format viewable without CHPS. The Configuration Focal Point sets up the process to send the map to the web server.

The file is saved in the **/bin** directory and is named **currentmap.png**. If you use the map with the report module, remember to include the map in the description of the report in the configuration file.

Synch the map and the report to your LDAD and send it to the RFC web server from there.

For more instructions on generating reports, use the job sheets below.

Job Sheet: Configuring the Report Module

References: *Information from the Deltares wiki on the* Report Module *and* *Report Export*

LESSON 4 WORKING WITH MODELS

Another way to add functionality to your office's CHPS is by supporting the "C" in CHPS. As you read through the lesson, think of ways your RFC could benefit from using a model from academia or another agency.

This lesson provides details on configuring CHPS to use external models.

By the end of this lesson, you should be able to:

- Describe types of models incorporated in CHPS.
- Explain function of General Adapter in model use.
- Write an instance of the General Adapter.
- Add a model run to a workflow to use the new model.

4.2 CURRENT MODELS

CHPS can utilize hydrologic and hydrodynamic models developed by the NWS, from other agencies, or academia. The following models are currently available for use in CHPS.

Keep in mind, using some of these models may require a General Adapter. Lesson 4.3 describes the purpose of the General Adapter (GA) module and Lesson 4.4 provides information on writing a GA.

Note: Specific details and explanations about each of the models listed in the chart above are beyond the scope of this course. Please visit the Deltares Delft-FEWS Configuration Guide for information on other models.

Routing - LAG/K, SARROUTE, LAYCOEF,MUSKROUT, TATUM are all NWS-developed hydrologic routing models. GLACIER is an NWS-developed model for glacier routing.

Reservoir - SSARRESV is a multiple reservoir regulation model, developed by the USACE and the NWS. RESSNGL is an NWS-developed single reservoir simulation. HEC-ResSim is USACE-developed single or multiple reservoir simulation.

Precipitation - SAC-SMA, APICONT, and SACSMA-HT are NWS-developed rainfall runoff models. SACSMA-HT includes a heat transfer component. RSNELEV and Snow17 are NWS-developed models. RSNELEV simulates the rain-snow elevation and Snow17 is a snowmelt simulation. SWMM is an EPA-developed **urban** rainfall-runoff model.

Etc. - The NWS developed several other models, which are available in CHPS.BASEFLOW models baseflow, CHANLOSS simulates channel loss, CONSUSE models consumptive use (diversions for agriculture, water supply, etc.), and Unit-HG simulates a unit hydrograph. The USACE developed HEC-RAS, a hydrodynamic model and HEC-HMS, a hydrodynamic model.

4.3 GENERAL ADAPTERS

CHPS is able to add external models listed on the previous page by using the **General Adapter** module.

The General Adapter exchanges data with models and executes the models. Since the data formats used in external models may not be in the same format as CHPS typically uses, think of the General Adapter as the “translator” for external models.

Communication between the General Adapter and a model is established through the published interface (PI), an XML-based data interchange format file.

Example: A General Adapter "translates" the data for the external model HEC-RAS.

The Process

The following is a brief description of how data is taken from a CHPS data directory, put through an external model, and eventually displayed in the Interactive Forecast Display (IFD).

1. The General Adapter provides the data required for a module to run in the PI format.
2. A module adapter then translates the data from the PI to the model’s native format.
3. The module adapter exports the results to the PI format.
4. The General Adapter imports the data back into CHPS in PI format.
5. Data is made available to the FEWS IFD.

Reference: *Published Interface information (Deltares wiki)*

4.4 WRITE A GENERAL ADAPTER

Writing a General Adapter is required before adding a new model. If the data is not "translated", CHPS cannot use it. Take a few minutes to familiarize yourself with the major elements in the General Adapter before moving on to the job sheet at the bottom of the page. The General Adapter module consists of three major elements in the XML file: general settings element, burn-in (model spin-up) profile element, and the activities element.

General Settings
The general settings element defines:

- the working directories associated with the General Adapter instance,
- an optional configuration description,
- time information,
- unit conversions,
- and PI version.

Burn-In Settings - Next, the burn-in profile element defines the burn-in period and initial value for cold state starts.

Activities Settings
The General Adapter module instance carries out a sequence of five activities, which are defined in this order:

1. **Startup Activities** are a cleanup step, run prior to a module run or any export or import of data, to remove old files.
2. **Import Activities** define all the items imported following a successful completion of the module run.
3. **Execute Activities** outline which of the external executables of Java classes to run.
4. **Export Activities** define all items exported through the **processing instruction** for XML, or PIXML (processing instructions for XML), to the external module.
5. **Shutdown Activitie**s run following completion of all other activities.

Considerations
Many of the steps in writing a General Adapter remind you to make sure the naming conventions are consistent. Unless the names match **exactly**, the adapter cannot do its job and the model run fails.

Take a look at the following job sheet to learn how to write a General Adapter.
Job Sheet: Writing a General Adapter

Reference: *Writing a General Adapter (HEC Reference Documentation, Appendix 2)*

4.5 MODEL RUNS

After writing the General Adapter, a few configuration steps are required before using the new model.

Recall, linking external models with CHPS occurs through the General Adapter. Specifically, adding a run is very similar to adding a module such as a transformation, or an interpolation.

Use the following steps when adding a run:

Adding a Model Run

1. Create a General Adapter configuration file in the specific module instance subdirectory located in the **ModuleConfigFiles** directory.
2. Register the module in the **ModuleInstanceDescriptors.xml** file located in the **RegionConfigFiles** directory.
3. Register the module in a specific workflow file located in the **WorkflowFiles** directory.
4. Register and configure the necessary cold state files, module parameters, Id maps, and time series displays.

Use the following job sheet to learn how to add a new forecast model.

Job Sheet: Adding a Model

COURSE SUMMARY

Introduction

- CHPS configuration utilizes XML as a framework for data.
- Remember, XML does not perform an action; it provides structure and transportation for information.
- The CHPS Configuration Focal Point identifies opportunities to optimize CHPS by:
    - decreasing use of storage space
    - establishing new data sources
    - setting up a model from a university or another agency.

Data Handling

- When adding new data sources to CHPS, consider these items:
    - What is the data format?
    - Is the data type already being imported?
    - How precise should the data be (i.e., how many significant digits should be used)?
    - How long do you want the data in the system? Determine the expiry time.
- To add a segment, follow these steps:
    1. Add a new site to the **Locations.xml** and **LocationSets.xml** files
    2. Create a subdirectory for the new segment
    3. Create a ModuleConfigFiles subdirectory and contents for the new segment
    4. Create the cold states files
    5. Create the workflow files
    6. Register the ModuleConfig and Workflow files
    7. Create a segment tree and entries in the IFD Forecast tab
    8. Update the ModuleInstanceSets
    9. Set up the forecast plot display
    10. Test the segment in a Stand Alone instance
    11. Add a rating curve and data
    12. Complete the spin-up runs
    13. Validate new configuration
    14. Upload the new configuration
- To optimize runtime for ensemble forecasts, you can remove unwanted time series from the ensemble runs to speed up processing time or by splitting up the workflows over several FSSs.
- Setting a time series as “temporary” decreases synch time, causes less database fragmentation, and saves space in the datastore.

Products

- In order to configure the Pi-Service, define the type of data you are sending to the office, the data locations (i.e.: site ID's, handbook 5 ID's), and the directory to which the data is being pushed.
- The steps to configure the Event Action feature are as follows:
    1. Choose an event code to use as a trigger.
    2. Create an action configuration file.
    3. Upload the XML file from Step 2 to the Admin Interface, choosing a suitable action ID.
    4. Create an Event-Action Mapping to link the event code and the action ID.
    5. Schedule the appropriate task with the same tag as configured in the XML file.
- There are two options for inundation mapping: 1) **Flood Mapping Module**, which produces 2D maps outlining inundated areas, and 2) **Using ArcGIS**.
- PC Raster, a type of environmental modeling software, utilizes the Transformation and General Adapter modules to create simulation models such as runoff models.
- The Report Module puts data into a desired format, generates the reports from FEWS, and displays the reports in HTML format. The report templates organize the information into text, charts, and tables.

Working with Models

- CHPS incorporates many models of various types, including models for:
    - Snow Melt
    - Rainfall-Runoff
    - Unit-Hydrograph
    - Urban Rainfall-Runoff
    - Hydrodynamics
    - Distributed Rainfall-Runoff
- The General Adapter module provides the ability to run external models, and it consists of three major elements in the XML file: general settings element, burn-in profile element, and the activities element.

Adding a Model Run

5. Create a General Adapter configuration file in the specific module instance subdirectory located in the **ModuleConfigFiles** directory.
6. Register the module in the **ModuleInstanceDescriptors.xml** file located in the **RegionConfigFiles** directory.
7. Register the module in a specific workflow file located in the **WorkflowFiles** directory.
8. Register and configure the necessary cold state files, module parameters, Id maps, and time series displays.

Congratulations. You reached the end of the course material!